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BIRD'S-EYE VIEWS.

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Birds alone, of all animate beings, may be truly said to "fall asleep" in death. When the silver cord of a bird's life is loosened, the "windows of the soul" are gently closed by unseen hands, that the mysterious rites attending the divorce of the spirit from the body may not be profaned by prying looks. With us, the first office rendered by sorrowing friends to one departed, is to close the eyes, to hide from view the mockery of life that looks out from between motionless lids. And when any mammal expires, the eyes remain wide open. With all, the stony stare of the glazed ball is the sign of dissolution. Only birds close their eyes in dying.

This is one of the differences between birds and mammals. Beautiful and wonderful as birds are in this respect, which comes to the reflective mind fraught with significance, we shall find them scarcely less beautiful and wonderful even as regards the material, physical structure of their eyes. Let us look into a bird's eye. Though the flash and glow of life be gone, and only dead tissues left, we shall still find more than we can fully comprehend, and everything that we see will excite interest and admiration.

To commence by saying that all birds have eyes, might appear at first sight to be superfluous. Yet this statement expresses one of the characters of the class *Aves;* for it is not applicable, without some qualification, to any other class of Vertebrates. Some representatives of each of the other classes either have no eyes at all or else very rudimentary ones. There are blind fishes and blind reptiles; and there are mammals at least "as blind as a mole." Among birds, the "wingless" species of New Zealand (*Apteryx*) are said to have the smallest eyes of all, and also to want one of the most characteristic structures of the avian eye-type,—the marsupium, a peculiar organ inside the eye, of which we shall learn something before we have finished our "Views."

We will examine first the accessory structures of a bird's eye,—those that surround and defend it, produce its movements, and keep it in working order; and then we will look at the more exquisite mechanism within.

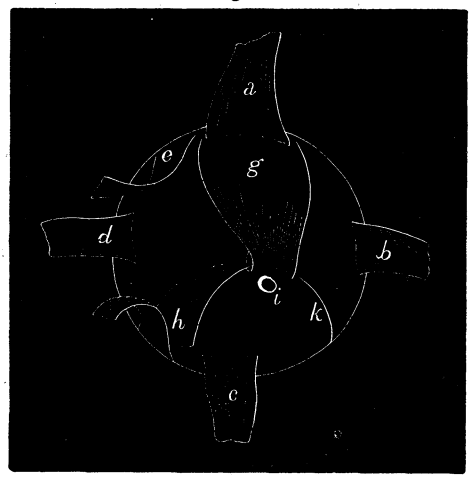
If we hold a dying bird in our hands, we observe that just as the last convulsive shiver agitates its frame, the eyes close by the uprising of the lower lid. In the primitive theatres of classic days, the curtain was lowered from the top to disclose the stage, and drawn up when the act was over; now these movements are reversed. Birds follow the classic usage, when the curtain rises upon the last scene of their life. Here at the outset is one difference between the eye of a bird and that of a mammal; and differences will multiply as we proceed.

The movements of the upper lid, in almost all birds, are much more restricted than those of the lower. There are few exceptions to this rule, and these chiefly furnished by the nocturnal raptores (*Owls*, *Strigidæ*), and certain fissirostres (*Caprimulgidæ*, e. g., Whippoorwill, Night-hawk). Both lids are composed of common skin externally, a membrane internally (the palpebral part of the conjunctiva, to be noticed presently), with a layer of fibrous tissue interposed for greater strength. Besides these tissues, the lower lid

has also a smooth oval plate of cartilage to stiffen it. The upper one is raised by a very small muscle, called *levator palpebræ superioris*, arising from the rim of the bony orbit, and running to the edge of the lid. There is no special lowering muscle; it is depressed by the action of part of another muscle, the *orbicularis oculi*, that nearly surrounds the eye, the chief office of which is to pull up the lower lid. The latter has a small distinct muscle for its depression.

A bird's eye, when wide open, appears almost perfectly circular; there are no well marked corners or angles (*canthi*) in front or behind, as in man and most mammals. Birds have no true eyelashes, but some kinds have two series of short modified feathers along the edges of the eyelids, that may be considered to correspond to the hairs found in this situation in mammalia.

Fig. 1.*



Now let us separate the lids and look at the eye. Not yet! "In the twinkling of an eye" a third lid is disclosed inside the other two, throwing a veil over the ball. This third inner eyelid is the nictitating membrane (*membrana nictitans*), a very curious structure, both in its movements and functions. It is a very thin, delicate, elastic membrane, transparent, or nearly so, of a delicate pearly-white color. While the other two lids move vertically, and have a hori-

*Fig. 1, right eyeball, seen from behind, showing the muscles. *a*, rectus superior; *b*, rectus externus; *c*, rectus inferior; *d*, rectus internus; *e*, obliquus superior; *f*, obliquus inferior; *g*, quadratus; *h*, pyramidalis, with its tendon, *k*, passing through pulley in quadratus (as shown by dotted line) to keep it from pressing on optic nerve *i*, then running to the edge of the ball, around which it passes.

zontal commissure, this one sweeps horizontally, or a little obliquely across the front of the ball, from the side next the beak to the outer one. When not in action, it lies curled up in the lower anterior corner of the orbit: when wanted for use it is pulled over the eye by the action of two muscles that grow on the back of the ball. The mechanism of its movements—the most perfect and ingenious that could be imagined—may be clearly understood with the help of the figure on the preceding page, which represents the back of the right eyeball, with all its muscles. Two of these act upon the nictitating membrane alone; *g* is the *quadratus* muscle, so called from its somewhat squarish shape, arising at the upper margin of the ball, and extending down on the ball to the optic nerve, *i*, where it ends in a broad flat transverse tendon, not attached to anything, but perforated so as to form a sheath or loop; *h* is the *pyramidalis* muscle, also so-called from its shape, tapering into a very long thread-like tendon, *k*, that first runs through the pulley-like sheath in the tendon of the quadratus, and then curves downwards and backwards over the ball, to the margin of the latter. It winds around, gets in front of the ball, and goes to be inserted into the lower corner of the nictitating membrane. If this slender tendon went straight along to the margin of the ball, and across the front, it would be right in the line of vision when the nictitating membrane, retiring to its corner, pulled it after. If it went directly under the ball to get to the front, it would not have the right direction to draw the membrane straight across the eye. So it must wind around the optic nerve. But now it would press upon, and interfere with the all-important functions of, the nerve, if there were no provision for keeping it away from the nerve when the pyramidalis exerts its force of traction. Here the quadrate muscle comes into beautiful action; it always contracts simultaneously with the pyramidal, and carries the tendon of the latter up out of the way of the nerve. Such is the ingenious, concerted action, of these two muscles,

which, though contracting in opposite directions, and mutually antagonistic as far as the nerve is concerned, eventually exert their force in the same direction, and work harmoniously for a common purpose. When the tendon of the pyramidalis is loosened by relaxation of the two muscles, the nictitating membrane is set free, and returns to its hiding-place by virtue of its own elasticity, just as the curtain of a coach window, after being forcibly drawn down, rolls itself up again when the lever that sets a spring in action is moved.

We understand the mechanism of the nictitating membrane better than we do its use. Birds can wink with this one eyelid alone, as might be expected from its name, wherein they beat mammals, that cannot wink without moving both lids. If we menace a bird's eye with the finger, we see that the nictitating is the first of the lids to rush to its defence. But the membrane is believed to be chiefly subservient to regulating the amount of light to be admitted to the eye. The eagle is, probably, able to soar aloft directly in the sun's rays, by drawing this covering over its eyes. Owls habitually sit, in the daytime, with drawn curtains to shut out the glare of light. It is also quite possible that many, or most birds that are rapid flyers, make great use of this membrane in guarding against various dangers to which the eye would be exposed in their dashing career. A screen is placed before the eye, which, while not preventing sight, as closure of the outer lids would, opposes the entrance of any particles of matter.

Three lids of the casket that holds the gem have been raised, and yet there is still another covering of the jewel within. A very delicate filmy membrane, not very apparent on ordinary inspection, is laid over the front of the ball, from around which it is reflected over on to the inside of the two outer lids. This is the *conjunctiva*, so-called because it joins the lids to the ball. It is a highly vascular tissue, with numerous tortuous blood-vessels ramifying all through it.

When these vessels become engorged with blood, as occurs in congestion or inflammation of the conjunctiva, they are very distinctly seen, and we have the state of things that is called "blood-shot."

Before examining the eyeball, which at length we have reached, let us glance at some accessory structures that are found lying with it in the socket. Properly speaking, birds cannot be said to cry; their features are immobile, and cannot wear an expression of grief; but they can shed tears. The tears are elaborated by two small glands that lie inside the eyelids, one in each corner. These are both "lachrymal" glands; but the one that lies in the corner next the beak is called the "Harderian gland." It is smaller than the other, nodulated in shape, and deeply seated inside the nictitating membrane, upon which it pours out a viscid or glairy secretion through a small opening, the mouth of a short duct that receives branches from all parts of the gland. The nictitating membrane requires constant oiling to work easily; the Harderian gland is an oil-can that can both make the oil and apply it when needed. The other, more truly a lachrymal, or "tear" gland, pours its secretion into the posterior or outer corner of the eye, near the juncture of the two outer lids, which are thus kept soft and moist on the inside. Tears, in the concrete, viewed anatomically or physiologically, are very different things from tears regarded abstractly as to their æsthetic relations; at any rate, they subserve a much more useful and sensible purpose. The "lachrymal duct," which is neither more or less than a drainage-tube for the eye, to carry off superabundant tears, or tears that have fulfilled their function and are worn out, commences by two little openings in the anterior lower corner of the eye, and runs into the nose, which is thus made a cesspool to receive the refuse waters of the eye. There is, beside the two above-mentioned, a third gland about the eye, very large and conspicuous in some birds, as the loons, albatrosses, and other swimmers, in which it is lodged in a

deep semilunar groove in the roof of the bony orbit. But it does not belong to the eye at all, and seems to be stowed there for want of room elsewhere. Its long duct runs along the top of the orbit into the nose, pouring out a secretion that lubricates the mucous membrane (*pituitary* membrane) of the nasal passages.

The lachrymal glands keep the eye's face clean, and relate chiefly, if not wholly, to the movements of the eyelid. The eyeball itself rolls about by the indirect aid of a different tissue—the *areolar*, or *cellular*, as it is indifferently called,—the interstices of which are filled with fat. Ordinarily, the socket of an eye is much too large for the ball, and of a conical, instead of globular shape, so that the ball can no more fit or fill it, than can a marble dropped into a candle extinguisher. A bird's eyeball is more nearly fitted to its socket than that of most mammals; still, it rests wholly or in great part upon a bed of fat. This soft, yielding, elastic substance gently presses the eye forwards, and holds it there in place, accurately adapted to the lids, while at the same time it allows the ball to rotate any way upon its own axis, and also keeps it greased. We have a great deal of fat in our own eye-sockets in health. The reason that people's eyes are sunken or "hollow" after a long illness, is because part of it is wasted away. While there is so much fat all around the eyeball, there is not a particle in the eye itself; this comparatively clumsy and stupid material would be like a bull in a china-shop in such a nervous quick-witted structure.

Ducks are said to roll their eyes up in a thunder-storm, and very likely they do, since all birds move their eyes about more or less when they are not asleep. But the amount and degree of motion that a bird's eye is capable of is small in comparison with that enjoyed by most mammals' eyes. This results partly from the shape of the orbit, and partly from the shape of the ball itself, which last is very singular, as we shall see in the sequel. Nevertheless, there are as many

muscles in a bird's eye as in a mammal's. They are six in number; whereof four are called "straight" muscles (*recti*) and two "oblique" (*obliqui*); though for the matter of that, they are all of them straight enough. The terms refer to their line of traction. The four recti all arise near each other, at the back of the bony orbit, around the hole (*foramen opticum*) that lets the optic nerve in from the brain; and go to be inserted into the eyeball at four nearly equidistant points around its margin. One (*musculus rectus superior*, *a*, in Fig. 1) goes to the top; another (*m. r. inferior*, *c*) to the bottom, antagonizing the first; the other two (*mm. r. internus*, *d*, *and externus*, *b*) respectively to the front and rear (or to what would be the inner and outer sides, if a bird's eye were directed forwards like ours), and also antagonize each other. The two oblique muscles arise farther forward in the bony orbit, near each other, and then diverge, one (*m. obliquus superior*, *e*) going obliquely upward, the other (*m. o. inferior*, *f*), obliquely downward: they are inserted near the margin of the globe, close by the insertions, respectively, of the upper and under recti muscles. Their action appears to be very limited: the most notable thing about them is that the superior one goes straight from its origin to its insertion, whereas in mammals this muscle changes its direction almost at a right angle, by passing through a fibrous loop, forming a pulley, suspended from the inner upper corner of the orbit, very much as the tendon of the pyramidalis changes its course by running through the sheath in the quadratus. The six muscles serve as so many ropes to pull the eye in different directions, and change the axis of vision; and all taken together, as stays to steady it. In the figure they are cut away from their origins at the bony orbit, and reflected away from the eyeball, to give a fair view of the pyramidalis and quadratus. The reader must mentally collect the six dangling ends, and fasten them in the places above designated.

There are some other structures in the socket of the eye,

besides those already described, and the ball itself. There are nerves, arteries and veins. Of the first named, the optic, or sight-nerve, is by far the largest, and is in fact the only one that can be discerned without more trouble than most persons would be willing to take to see it, and more skilful dissection than most can make. It is described further on, as it can be more conveniently studied in connection with the ball itself. Other nerves go to the muscles of the eye. The *oculo-motor* divides into numerous branches, which are distributed to the inferior oblique, and all the recti except the external. The latter claims a nerve of its own (the *abducens*), and so, also, does the superior oblique, to which the *patheticus* is exclusively distributed. These nerves all come directly from the brain. We do not know why they are so unequally distributed. There are some more nerves in the socket which, however, do not particularly concern the eye, and therefore need not concern us. There is little to be said of the blood-vessels: they ramify everywhere, supplying all the structures of the eye with food. The arteries bring the nutritious fluid, and the veins carry it away when the nourishment has been extracted for the repair of the destruction that constantly goes on in all living tissue, and when it has become loaded with carbon, and other effete or deleterious matter.

So much for the surroundings of a bird's eye,—the setting of the precious stone: now we are prepared to look inside. An eye is a perfect microcosm, in which we find almost every kind of tissue that enters into the composition of the rest of the body. If the reader's interest has been awakened, as we hope it has, by what has gone before, we can, with confidence, invite him to look deeper into a bird's eye, and give him assurance that a far more beautiful "View" will be presented to him. — *To be concluded.*